1 Introduction

Acronyms

First, a few useful acronyms:

- A/E - Architect-Engineer
- A/E/C - Architectural, Engineering, and Construction
- AIA - American Institute of Architects
- ANSI - American National Standards Institute
- ASTM - American Society for Testing and Materials
- CAD - Computer-Aided Drafting
- CADD - Computer-Aided Design and Drafting
- CSI - Construction Specifications Institute
- DoD - Department of Defense
- FM - Facility Management
- GIS - Geographic Information System
- IAI - International Alliance for Interoperability
- IFC - Industry Foundation Class
- IOC - Intelligent Object Class
- ISO - International Organization for Standardization
- NIBS - National Institute of Building Sciences
- SI - International System of Units (Le Système International d'Unités)
- TSTC - Tri-Service CADD/GIS Technology Center
- UDS - Uniform Drawing System

Scope

This manual provides guidance and procedures for preparing Computer-Aided Design and Drafting (CADD) products within the Department of Defense (DoD) Tri-Services.

Chapters 1-7 of this manual address topics such as presentation graphics, level/layer assignments, electronic file naming, and standard symbology. Appendices A-E contain tables on model and sheet file level/layer names, color comparisons with associated line widths, as well as Architectural, Engineering, and Construction (A/E/C) CADD symbology.

Purpose

The purpose of this manual is to set a basic CADD standard to ensure consistent electronic deliverables (products) within the DoD Tri-Services. These consistent deliverables are part of a comprehensive installation life-cycle management strategy. This manual sets a CADD standard specifically for the architectural, engineering, and construction disciplines of facilities development. As this manual evolves, it will be integrated with other standards initiatives by the Tri-Service CADD/GIS Technology Center (TSTC) such as Architect-Engineer (A/E)

Deliverables Guidelines, Tri-Service Spatial Data Standards, and Facility Management (FM) Standards.

Background

The immediate benefits of CADD standards are many: consistent CADD products for customers; uniform requirements for A/E deliverables; sharing of products and expertise; and collection, manipulation, and exchange of database information. Recognizing such potential benefits, each of the Tri-Service agencies independently initiated efforts to establish CADD standards in the late 1980's. The Air Force Logistics Command (1989) released the "Architectural and Engineering Services for CADD Implementation Within Air Force Logistics Command." Headquarters, U.S. Army Corps of Engineers (1990), published Engineer Manual 1110-1-1807, "Standards Manual for U.S. Army Corps of Engineers Computer-Aided Design and Drafting (CADD) Systems." In 1993, the Naval Facilities Engineering Command distributed its "Policy and Procedures for Electronic Deliverables of Facilities Computer-Aided Design and Drafting (CADD) Systems."

To consolidate these efforts into a single standard, the TSTC was tasked to develop standards for the A/E/C disciplines, facility management, and GIS planning. This manual presents the TSTC's effort at standardizing CADD requirements for A/E/C design and construction documents. To facilitate the use of this standard, a supplementary software package will be provided that automates the use of the standard. This software will allow the operator to select preset system variables to align with the requirements of the "A/E/C CADD Standard Manual" to ensure consistent and easy compliance with the standard (see Chapter 6, "Tri-Service A/E/C CADD Standard Implementation Tools").

International System of Units (SI) Considerations

For this standard manual, the impact of the SI, more commonly referred to as the metric system, is addressed on such items as drawing scales, sheet sizes, and dimensioning. The SI was established by the General Conference of Weights and Measures of 1960, as interpreted or modified from time to time for the United States by the Secretary of Commerce under the authority of Public Law 94-168, the Metric Conversion Act of 1975, and the Metric Education Act of 1978. As of January 1, 1992, in accordance with Public Laws 94-168 and 100-418, the Omnibus Trade and Competitiveness Act of 1988, and Executive Order 12770, "Metric Usage in Federal Governmental Programs," July 25, 1991, all new and revised construction standards and criteria must be developed using the SI.

Future Technologies

There are several ongoing initiatives to create a universal language for collaborative work in the area of building and construction software. This work stems from the need to automate current building and construction tasks to become more efficient and cost effective. One of these initiatives is by the International Alliance for Interoperability (IAI), a nonprofit building industry alliance comprising architects, engineers, contractors, software vendors, government agencies, research laboratories, and universities. The goal of the IAI is to unite the AEC/FM business by specifying Industry Foundation Classes (IFCs) as a universal language. The concept behind the IFCs is to create a series of standard intelligent software objects for the building industry that allow all process disciplines (i.e., architects, designers, engineers, builders, facilities managers, etc.) to exchange information. The IAI is developing IFCs that allow current software packages such as AutoCAD and MicroStation to share building and construc-tion data. IFCs would improve the quality of the life cycle of a building from

construction through maintenance and ultimately to demolition. These improvements would result from reductions in expense and delivery time, enhanced communi-cations, and an increase in discipline proficiency.

A prerequisite of this effort is the deployment of mechanisms capable of retaining knowledge during the project life cycle. Intelligent Object Classes (IOCs) can serve this purpose. An IOC gathers information during the progression of the project and makes it available to the participants. Starting from the design phase, IOCs collect additional data about an object, for example, "how to design" or "how to construct" that particular object. The structure of an IOC contains information about the following:

- Generic attributes of common use (e.g., identification, material).
- Methods to support specialist tasks (e.g., volume calculations).
- CAD representation information including geometry and topology.
- Interrelationships with other objects.

In tandem with the IAI effort, the TSTC is developing nongraphic attribute data as part of the A/E/C CADD Standard. This attribute information will be distributed for review in 1999.

Interchangeable Terminology

Within the various commercially available CADD systems, many identical or related concepts are given different names. To aid users of this manual, some instances of related or interchangeable terminology used in MicroStation and AutoCAD are listed in Table 1.

Target Systems

This manual is not targeted toward any specific CADD system. However, to ensure successful translations among CADD applications, certain system-specific characteristics were considered and the standard adjusted accordingly. In preparing the standard, several baseline decisions were made:

- The standard must be applicable to commercially available CADD packages. AutoCAD Release 14 and MicroStation Versions 95 and SE were chosen based on their prevalence in the DoD Tri-Services and their availability to the Tri-Service through the Installation Management/Facilities CAD2 contract.
- The standard is based on CADD applications that utilize layer/level names and reference files.
- The standard requires every final plotted drawing sheet to have its own separate electronic drawing file.
- Since three-dimensional files are not compatible with two-dimensional files, it is recommended that all drawings be created as 3-D files.

Additions/Revisions

This standard is intended to be neither static nor all-inclusive and thus will be updated and enhanced as appropriate. Suggestions for improvements are strongly encouraged so that subsequent updates will reflect the input and needs of CADD users within the Tri-Services.

Recommendations or suggested additions should be sent to:

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Waterways Experiment Station
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Or by e-mail at: spangls@wes.army.mil

Table 1
Interchangeable Terminology

MicroStation	AutoCAD	Definition
Integer d/b	64-bit floating point d/b	The method for storing drawing attribute data.
Disk-based	Memory-based	Where drawing data are stored until the active file is closed.
Auxiliary Coordinate System (ACS)	User Coordinate System (UCS)	An XYZ coordinate system where the origin is selected by the user.
Active	Current	File or object in use.
Cell	Block	Single or multiple entities grouped together to create a single element.
Dimension attributes	Dimensions styles	Controls the appearance of dimension elements.
.dgn	.dwg	A DOS-based extension for drawing files.
Drop	Explode	Converts an element into multiple entities.
Dynamic update	Dragmode/rubberbanding	Display of element(s) being drawn or modified as pointer/cursor moves on the screen.
Element	Entity	A single object contained in a drawing.
Fit	Zoom all	Displays all graphics currently in the drawing file.
Global origin/design cube	World Coordinate System/Origin	Defines the location(s) of all entities in a design/drawing using the Cartesian coordinate system.
Identify/accept	Select/pick	Entity or entities chosen for manipulation or modification.
Image	Slide	A screen capture of graphics in raster format.
Key entry field	Command prompt	Allows for keyboard input from users.
Key point snap	Object snap (Osnap)	Controls the selection location for entities.
Levels	Layers	Used as transparent overlays for display graphics.
Line style	Linetype	Defines the appearance of lines.
Linestring	Polyline	Connected line segments.
Locate tolerance	Pickbox	Identification/selection limits for the drawing cursor.
MDL/Visual BASIC	ARX/AutoLISP	System-specific command language.
Message field	Status line	Displays current drawing status and/or text output from the application.
Monument point	Insertion point	Benchmark point used to place objects in a drawing.
Move element	Move	Relocation of entities.
Patterning	Hatching	To fill an area within a drawing with a symbolic texture.
Precision key in	Coordinate entry	User-defined XYZ values.
Reference file	External reference	A design/drawing file attached to an active drawing.
Seed file	Prototype drawing	A drawing design template file.
Tentative/Data point	Pointing/pick point	A point within the drawing selected using a pointing device.
Update	Redraw/Regenerate	Refreshes screen display.